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Improvement of Fodder Markets and Identification of Crop Varieties with Improved Fodder Characteristics in Selected Disadvantaged Areas of India

PROJECT REPORT

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Project Report

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1. Introduction

1.1. Background to the study

Livestock production, especially dairy, has long been an important activity for smallholder and resource-poor farmers in India, both for household nutrition and income. Generally, crop residues and communal or free-of-cost resources provided the basis for feeding the animals. However, rising levels of human and livestock densities in combination with stricter enforcement of environmental regulations and intensified cropping patterns have reduced access to common feed sources. This is especially relevant for the densely populated Indo-Gangetic Plains where most of the South Asian rural poor live and where most of the communal lands have been progressively privatised.

Most of the livestock in these regions are kept in mixed farming systems, where crop residues—mainly cereal straws--have been an important feed resource (>44% of feeds) as in much of the rest of India (NIANP 2003). With the increasing unavailability of grazed or collected feeds, straws are currently dominating livestock feed rations.

India is deficient in the supply of fodder, resulting in very low levels of productivity that limit marketable surplus of milk. In Bihar State, over 50% of the land area is planted to rice, and rice straw along with smaller quantities of wheat straw and some pulse residues form the main animal feeds. Recent studies in the Indo-Gangetic Plain have highlighted the problem of insufficient fodder and the poor nutritive value of fodder, a problem which becomes more acute in the more eastern parts of the region where agricultural resources–particularly arable land and water–become scarcer. This fodder scarcity affects most farmers but is particularly acute for landless and those with access to only small areas of land.

Chronic feed deficit is the major constraint to animal production in eastern states of the country. Most of the dairy farmers are smallholders having one or two local-breed milch animals, which are raised on crop residues and natural pastures with under-employed family labour. Feeding grains, oil cakes and green nutritious fodder are generally restricted to some crossbred cattle. The feed and fodder deficiencies, in fact, have been the main limiting factors in raising livestock productivity. Studies have indicated, for example, that a one percent increase in the digestibility of cereal straws increases milk yield in dairy cattle by 5-6 per cent (Baruah 2005).

However, especially in India's poor eastern states, the growth of the rural population is still leading to decreasing farm sizes, while rising demand for milk and improving marketing opportunities stimulate continuous growth in dairy production. Thus, the availability of fodder is a serious issue, especially for resource-poor livestock keepers with little or no land for cultivation. The level of this constraint varies temporally and spatially, creating scope for storage and trade. It has been observed that farmers generally store a considerable proportion of their harvested fodder and that large amounts of fodder are traded, both locally and over longer distances. But the structure and functioning of those markets are poorly understood and opportunities for improving the efficiency of fodder marketing as a potential tool contributing to the alleviation of fodder scarcity have not been adequately explored. Fodder markets are particularly important for the poorest and landless sections of these communities, which have very limited ability to produce their own fodder, but

need access to quality fodder at reasonable prices to be able to produce milk economically and at competitive cost. Fodder trading is also an important livelihood activity for the poor who engage in it directly or who are employed in this value chain. To assess the contribution of crop residues and compare market structures, the production, trade and consumption of concentrates was also considered in this study.

A crucial aspect in regard to the supply of fodder which has been given little consideration to date is quality. It has been observed in other regions that fodder is differentiated by quality, resulting in significant price differences. In view of continuing intensification in dairy production, feed quality will play an increasingly central role. Even relatively small improvements of quality in the major feed components can enable significant productivity increases (Rai 2005). It has been shown in various crops that while nutritional quality of residues varies considerably between varieties, this variation is not correlated to grain yields. Thus, considering the nutritional quality of residues in crop improvement programmes would seem a very attractive pathway to increase the supply of better quality fodder. To assess the quality aspects of crop residues, it is necessary to first unravel the relationship between quality perceptions of farmers and traders and feed quality based on laboratory analysis.

1.2. Objectives and scope

The overall objective of the study was to improve the livelihoods of resource-poor livestock producers by alleviating fodder scarcity. The specific objectives of the project were:

- Develop a systematic understanding of fodder markets and to what degree they recognize the nutritive value of fodder.
- Quantify the variation in nutritive value of different varieties/cultivars of feed-food crops in relation to market availability and perceptions.

The study was conducted in Bihar state for the following reasons.

- It is amongst the poorest states in the region, and livestock is an important source of livelihood, enabling a direct poverty relevance of the study's findings.
- Its agricultural sector is diverse and thus also its production of crop residue based fodder. Both the share of cereals in the cropping pattern as well as the shares of individual cereals vary across districts within the state, which has implications for quantity and quality of fodder.
- Both wheat and rice straw are widely fed in this state located between rice oriented eastern and wheat focused north-western states.
- The demand for fodder is also determined by urban producers, both within the state—mainly around the capital Patna—and beyond its borders. A considerable export of fodder to Kolkata in West Bengal has been observed.

1.3. Approaches

The study was divided into three parts. A participatory rural appraisal (**PRA**) was conducted to identify the actors in the fodder market and get a preliminary picture of the market to facilitate the design of a detailed survey among the actors. Then a formal sample survey was conducted. Thirdly, fodder samples were collected and analyzed for quality. Detailed methodology and results for each component are presented below.

2. Participatory Rural Appraisal: Methods and Results

2.1. Approach and method

Discussions with key informants indicated that there are five types of actors that are important in fodder markets in the state: producers, consumers, traders, feed millers and commission agents. Five semi-formal interviews were conducted with representatives of each of these types to draw an overall picture of fodder marketing in Bihar. PRAs were conducted in 4 districts, 2 in the surplus zone and 2 in the deficit zone. Then 12 Focus Group Discussions (**FGD**s) were organized at 12 sites in the state with the help of scientists of the Sanjay Gandhi Institute of Dairy Technology, Patna and the State Farmers' Commission, Bihar. At each site, some producers, assemblers, traders (vendors, retailers and wholesalers), and commission agents from fodder markets were assembled and discussions on different aspects of fodder marketing were held.

2.2. Results

Important forage and concentrate feeds

Crop residues and by-products are the key components of livestock feed. Dry fodder constitutes the largest proportion of forage accounting for about 82% of the feed requirement. Straws of paddy and wheat together contribute to about 95% of dry fodders consumed by livestock in Bihar.

The proportion of green fodder in total livestock feed is close to 10%. About 55% of green fodders are cultivated. Maize, sorghum, berseem, napier grass, and some of the legume species are mostly cultivated. The stovers of green maize and sorghum account for about 30% of the total green fodder, particularly in maize growing areas, and berseem and napier grass constitute 20% of the green fodder.

Cut grasses, weeds and rogues are also important sources of green fodder—accounting for about 40% of the green fodder—and given to the livestock after chopping. In addition, leaves of some trees and banana trunk also supplement green fodder.

The proportion of concentrate in the total feed is close to 8%. Oil cakes, *choker* (wheat bran and husks of pulses), *darra* (crushed grains) and *chunni* (broken and discarded pulses) are the most important concentrates. Manufactured compound feeds are also used to some extent. Oil cake, compound cattle feed and other concentrates account for 30, 25 and 45% of total consumption of concentrates, respectively. Due to alternative uses of many of the concentrate items, their use may decline in future.

Storage

Every household that owns livestock stores fodder for future use. Storage practices differ according to types of feed items. Generally, paddy straw is stored in a corner of a courtyard in the open. The loose piles of paddy straw are stacked together. This type of storage is common in the areas where paddy is harvested by combine. The next important practice is storage of paddy straw in heaps/bundles arranged in a cylindrical shape covered by a conical shaped cap made of paddy

straw/thatch in the fields or near the dwelling house. The conical shape of the cap prevents water from percolating inside the heap and the whole pile of straw remains unaffected except a thin layer on the top. Sometimes when the quantity is fairly small, paddy straw is also stored in the dwelling house.

Chopped paddy and wheat straws are never stored lose in the open. Most of the time, these are stored in the dwelling houses of the producers or the users. Special bamboo storage structures (locally known as *bukhari, bhuskar*, etc.) are also built and used to store chopped paddy and wheat straws solely or along with food grains. Some affluent, big producers and traders have also constructed cemented structures to store fodder and grain.

Fodder and concentrate marketing

Fodder marketing in Bihar has no formal organized structure or formal institutional support. Paddy and wheat straws are the major traded fodders. Green fodder is also traded but its proportion is quite insignificant.

Fodder marketing involves a number of actors along the supply chain. The most common fodder supply chain begins with the producers and proceeds further along a number of different channels with the help of various kinds of actors such as assemblers and small vendors, commission agents, retailers, wholesalers and processors, and ends with the ultimate users who are scattered across the state.

There are five main actors or points of action in the wheat and rice straw supply chain: producer, trader-1 (vendor), trader-2 (wholesaler), trader-3 (retailer) and consumer. In between, there are other small actors such as bullock cart owners, assemblers, and commission agents who serve different principal agents to facilitate transactions. About 60% of the marketed surplus of straw is sold by producers to trader-1 and 3, 30% to trader-2 and 10% to consumers directly (Figure 2.1). There are many retailers who maintain good contacts with producers and purchase fodder directly from them. The longest supply chain involves the producer, trader-1, trader-2, commission agents, trader-3 and finally the ultimate consumers.

Different types of means of transport are used to carry fodder from one place to another, depending on distance and purpose of transportation. Head loads are common for transportation of green fodder from the field to farms for self use. For localized fodder and concentrate trade (<10kms), mainly bullock carts are used. A bullock cart load of wheat straw fetches a price of Rs. 1200-1500 and roughly weighs 4 to 5 quintals[1]. A number of bullock carters (*bail gadiwalas*), particularly in fodder surplus zones, are involved in fodder trade. Tractor trolleys are also very important for fodder transportation along main highways for longer distances. Most of the inter-state and interregional trade is done by trucks.

[1] One quintal = 100kg

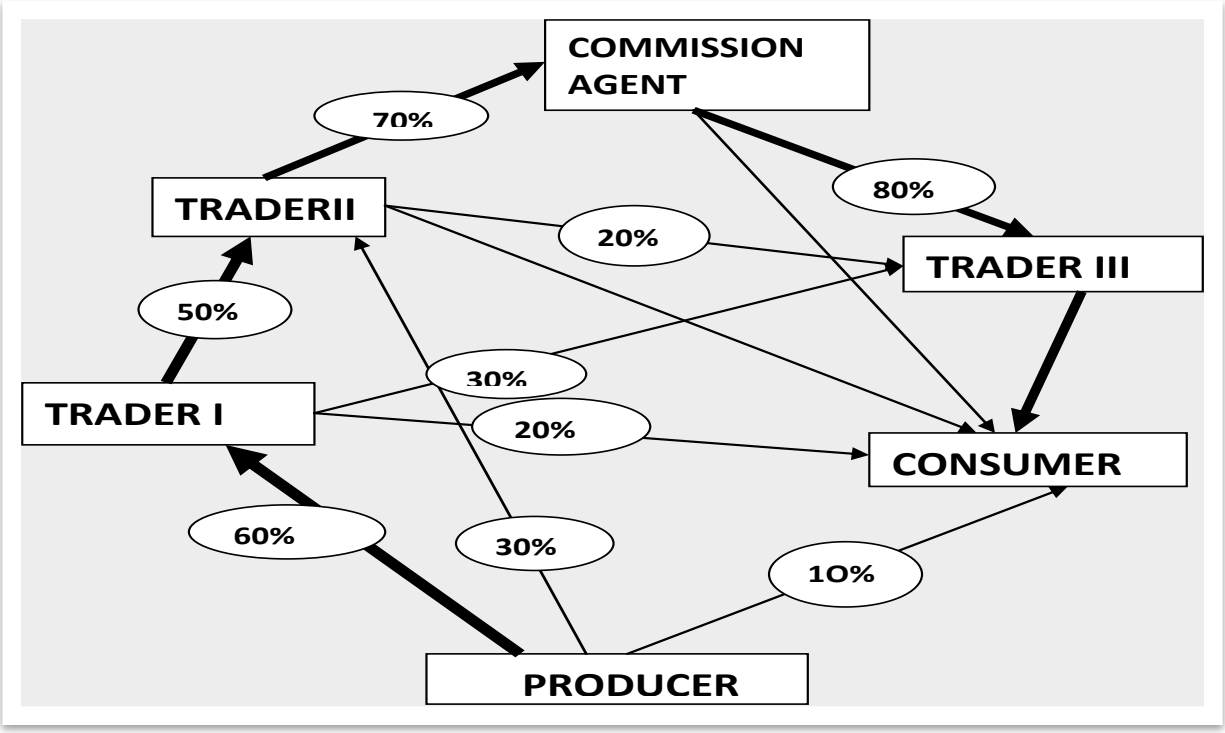

Figure 2.1: Flow of fodder transactions among different actors in Bihar

In the case of inter-state movement of fodder, some very interesting patterns have emerged. Patna, Jehanabad, Nalanda, Sheikhpura, Lakhisarai and Rohtas, which are the fodder surplus districts, are the main supply centres for dry fodder. Patna is the biggest transit point for fodder marketing. The state that buys the most fodder from Bihar is Jharkhand, which is highly deficient in fodder supply from its own production. Bihar also imports fodder from other states, notably from Uttar Pradesh for wheat straw sold directly in the fodder deficit regions of north Bihar.

Information plays a critical role in fodder marketing. Different actors in the fodder market use different modes of communication to elicit information and contact their counterparts. Almost all fodder traders and agents own a cell phone, which helps them to contact buyers and sellers, especially when making contacts at a longer distance. However, face-to-face communication has not lost its significance. It is the next important mode, which is still popular among the petty traders in rural fodder markets.

Price formation and determinants of price

The process of price formation is simple. Farmers either accept the prevailing market price of fodder in the nearby region or negotiate with the purchasers using the prevailing local market price as a reference. Of course, exigency of demand and availability of fodder are considered while prices are negotiated. Deficit zones often witness extremes of flood devastation and face critical shortages of livestock feed as a consequence. Under such circumstances, demand for livestock feed rises many fold and hence price negotiations are driven by the exigency of demand. Otherwise, in normal situations price negotiation remains supply driven. However there are other considerations, too, that affect the fodder price. Certain quality aspects like good lustre, taste, cleanliness, softness, and moisture contents of fodder are considered when prices are determined.

There are usually wide differences in fodder prices between the surplus and deficit zones with prices in deficit zones being 17 to 50% higher than those in surplus zones. At the time of the study, a quintal of paddy straw was selling at a price of Rs. 100 in the surplus zone compared to Rs. 150 in the deficit zone. The average price of wheat straw in the surplus zone was Rs. 200 per quintal whereas in the deficit zone it was Rs. 300. The price of cultivated green fodder is also usually determined on the basis of location. In surplus zones, a hectare of green fodder is sold for Rs. 15-25,000, whereas in deficit zones, it is sold for between Rs. 25-35,000. Cut grasses and green fodders are also sold in some of the areas at the rate of Rs. 1 to 1.5/kg. Both cash and credit sales are practiced in the livestock feed market: though cash sale is preferred, circumstances often force producers, sellers and their clients to facilitate fodder feed marketing on credit.

Constraints in feed marketing and suggestions for improvement

Fodder and concentrate markets in Bihar face several constraints. Many of these constraints are generic in nature and presently are not being addressed.

Storage difficulties and lack of appropriate storage facilities seriously affect year-round availability of fodder. Most of the marketable surplus of fodder is generated by marginal and small farmers who are in the majority in the state, but have limited storage capacity. Due to difficulties in fodder storage, they are forced to sell immediately after harvest. Even if stored, a large proportion of fodder gets spoiled or destroyed due to improper storage facilities.

Transportation of fodder from producers to the market is fairly inefficient. Due to poor road conditions in rural areas and the absence of any block-making or baling technology, transportation and transaction costs are very high. It is estimated that marketing 100kg of fodder generates revenues of Rs. 395, of which the fodder raw material accounts for about 32% only and the rest is the marketing cost including transportation. The largest cost item is transportation which accounts for about 36%.

Fodder is a bulky item, which makes its trading cumbersome and handling difficult. Some traders use compressing machines to make fodder blocks. This makes storage easy and transportation convenient, and so more cost effective. The majority of machines used for compressing fodder are obsolete. These machines, which were designed for the compression of jute in the jute factories during the colonial period, serve the purpose of traders and transporters to some extent, but are inefficient. There is a need to design and develop new economical and cost-effective machines to help the fodder sector. The Government of Bihar has planned to establish two plants for preparing feed blocks: one each in a fodder-deficit region (Samastipur) and in a feed-surplus region (Patna).

Quality control of manufactured compound feed and concentrates is also essential. Most traders and consumers feel that there should be a mechanism to ensure quality of manufactured feed and nutritional supplements. Millers feel that prices of most raw materials are escalating day by day, and this compels a number of millers and manufacturers to go for cheaper substitutes or to use inferior material. They seek cost-effective and improved technology for manufactured feed. Public sector

R&D can play an effective role in this regard, and can also be achieved through public-private partnership.

2.3. Conclusions from the PRA

Livestock is an integral part of the rural economy in Bihar and fodder is a critical input for livestock development. The data indicate that a huge gap exists between demand and supply of both dry and green fodder. Most of the south of Bihar comprising agro-climatic zones IIIA and IIIB are fodder surplus areas because of irrigated cultivation of paddy and wheat. Agro-climatic Zone I and Zone II are fodder deficit and mostly depend on fodder surplus regions for their requirements. Fodder production is seasonal, but demand is constant throughout the year or until the next crop season. Inadequate storage facilities and space sometimes force producers to dispose of much of their fodder rather than storing it for later use for their own needs or sale when prices are higher. To promote fodder production and trade, it is necessary to improve storage systems on-farm as well as en route to distant markets. Fodder markets are unorganized and informal and the role of the public sector/government is negligible. Most fodder markets occur without any dedicated market place, often along roadsides and without legal credentials. Having specific market places may facilitate flow of market information, increase interaction among buyers and sellers and facilitate transparency and competition leading to fairer prices.

Fodder is a bulky item, which makes its trading cumbersome and handling difficult. Some traders use compressing machines to make fodder blocks. It is important to develop cost-effective and efficient fodder compressing technology to ease handling and transportation as well as generate cost savings. Quality control of manufactured compound feed and concentrates is also essential. Most of the traders and consumers feel that there should be a mechanism to ensure quality of manufactured feed and nutritional supplements. Development of technology for cost-effective and nutritive feed requires urgent attention and here public sector R&D can play an effective role. This can also be done in public-private partnership mode.

3. Survey of feed market actors

3.1. Approaches and methods

The PRA showed that there exists a huge gap between demand and supply of fodder (both dry as well as green). Most of south Bihar comprising agro-climatic zones IIIA and IIIB are fodder surplus because of cultivation of paddy and wheat under assured irrigation facilities. Agro-climatic zones I and II are fodder deficit and mostly depend on fodder surplus regions for their requirements. The PRA also identified various types of actors in the fodder and concentrate markets. In order to understand in more detail how fodder markets actually work and perform, a detailed survey was conducted among representative market actors so that more specific constraints in the market could be identified for possible interventions (technical, institutional and policy) for improving its performance.

Two contrasting zones, namely deficit and surplus, were identified and four districts from each zone were selected for detailed study using a multistage stratified random sampling method (Figure 3.1).

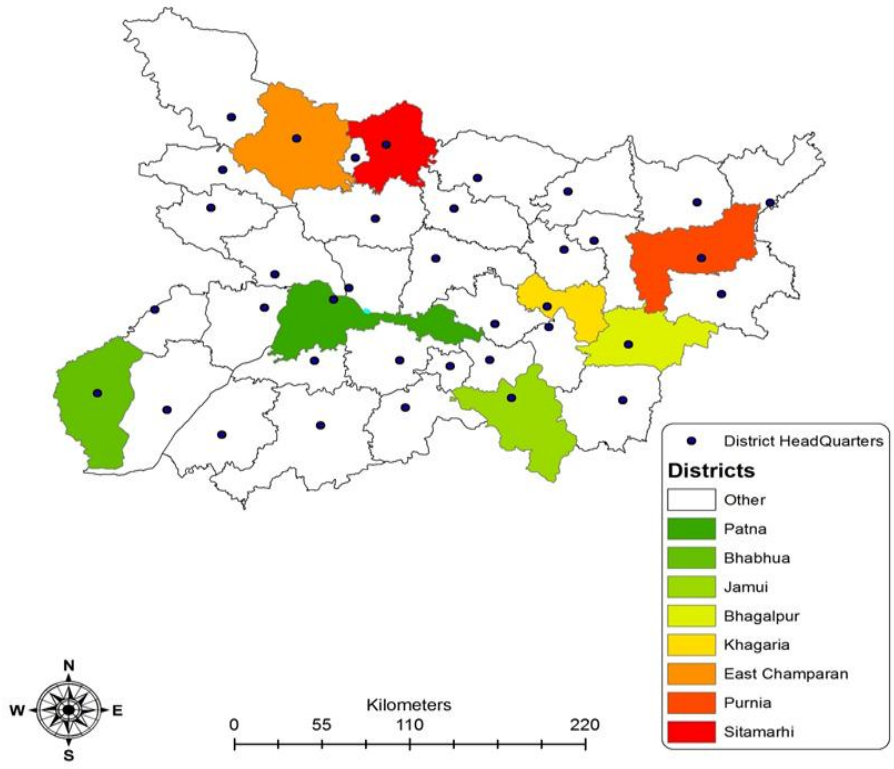

Figure 3.1: Location of selected sample districts in Bihar

Bihar is divided into four agro-climatic zones. For the present study, we classified these agro-climatic zones into two groups based on fodder production status, i.e. surplus and deficit. Using a stratified sampling approach, four districts were randomly selected from each of the surplus and deficit groups. The selected districts from each group were: Bhabhua, Patna, Jamui and Bhagalpur from the surplus zone; and East-Champaran, Sitamarhi, Purnea and Khagaria from the deficit zone. From each district, two tehsils (administrative sub-unit) were then randomly selected. Within each tehsil, two villages were next randomly selected. The Government of India Village Census (2001) has been used

as the sampling frame for selecting administrative sub-units and villages. From each village, 15 farm households were selected using a randomizing village walk approach. Thus, a total of 480 farm households were surveyed. In addition, other actors of the feed marketing chain were sampled from each district: fodder traders (10), concentrate traders (5), concentrate millers (5) and urban-dairy consumers (10). The total survey sample thus included: 476 fodder producers, 80 fodder traders, 80 fodder consumers, 40 concentrate traders and 40 concentrate millers. Separate questionnaires were prepared and pre-tested for each group.

After the survey, each type of actor was classified into sub-categories based on their functions and marketing behaviour.

- The fodder producers were stratified into three categories depending on their selling and/or buying status: net sellers (140), net buyers (221), and autarkic (113).
- Traders were stratified depending on the nature of their business into vendors (27), wholesalers (4), and retailers (49).
- Consumers were stratified into three categories; urban commercial dairy producers (80), rural commercial dairy producers (73) and other rural farmers (401).

3.2. Results and discussion

Fodder production

Residues of the principal crops, namely paddy, wheat, maize and pulses, are the main sources of dry fodder in Bihar. These crops constitute about 90% of dry fodder produced in the surveyed villages. Maize is not an important source of fodder in the surplus zone. Production of dry fodder is closely related to the size of land holdings; in both the zones, net sellers had larger land holdings and produced more dry fodder than net buyers.

Rice-wheat cropping systems were common in the surplus zone and these two crops constituted more than 90% of dry fodder production, whereas in the fodder deficit zone these two crops constituted 78 percent of total dry fodder production in surveyed villages. Pulses were the third most important dry fodder-producing crop in the surplus zone, whereas maize was the third most important in the deficit zone due to adoption of winter maize over large areas. Average production of dry fodder per household in the surveyed villages in the surplus zone was about twice that in the deficit zone, mainly due to the larger land holdings found there. The proportion of area used for production of the main dry fodder-producing crops (rice and wheat) was higher in the fodder surplus zone (75%) than in the fodder deficit zone (68%). The recent decline in area under rice and the use of combine harvesters in rice and wheat crops, particularly in the fodder surplus zone, could present a threat to fodder availability in Bihar. Retrieving straw from the field after combine harvesting is more costly and reduces the quality compared to manual harvesting, where cereal bundles are carried from the field for threshing.

Fodder sales from the producer perspective

Inter-zone, intra-zone and inter-state dry fodder marketing are all common in Bihar. The amount of dry fodder sold was higher (5.5 tonnes (t)/household) in the surplus zone than in the deficit zone (3.8 t/household). As discussed earlier, paddy straw was the most important dry fodder accounting

for 67% of sale volume; its share was higher in the surplus zone: about 72%. Wheat straw was the second important dry fodder with respect to production and marketing.

Despite much higher production of wheat straw in the surplus zone, farmer preference there for feeding their animals with wheat straw rather than paddy straw translated into a smaller share of their wheat straw sold (39%) compared to the deficit zone (57%), with the quantities sold per household being almost identical in both zones. There is no market for maize stover in the surplus zone due to the negligible area under maize there. Livestock keepers in the surplus zone are not even aware that maize stover can be used as fodder. Marketing of pulse straw is not a common practice and less than one quintal was sold per household in the surveyed villages. About 20% of output in the surveyed villages in the surplus zone and 11% in the deficit zone was sold. Per household sale of pulse straw was higher in the surplus zone (0.15 t) than in the deficit zone (0.03 t), reflecting a larger area under pulses in the surplus zone.

Among the major dry fodders in the surplus zone, pulse fodder is the most expensive (Rs. 1.94/kg) due to the higher preference given to it, followed by wheat straw (Rs. 1.17/kg) and paddy straw (Rs 1.07/kg). On the other hand, wheat straw was sold at a higher price (Rs. 1.33/kg) in the deficit zone, followed by paddy straw (Rs. 1.30/kg) and pulse straw, which was sold at much lower price (Rs. 1.14/kg). It is noteworthy that pulse straw fetched the highest price in the surplus zone whereas wheat straw is the most expensive in the deficit zone. Price behaviour of different types of fodder is influenced by farmer preferences in each zone. As expected, the prices of the main fodders (paddy and wheat straw) were higher in the deficit zone than in the surplus zone.

The price of fodder was linked to type of purchaser. In the deficit zone, 51% of fodder sold by farmers was sold to fellow farmers in the village for higher prices than to other buyers. In the surplus zone, farmers sold more than 70 percent of fodder to vendors for lower prices. In the surplus zone, selling to vendors was preferred because they purchased almost all the surplus fodder at the same time. Wholesalers and dairy producers did not buy much fodder directly from producer farmers in either zone. However, farmers sold 6 to 8% of fodder to retailers in the surveyed villages. In both zones, almost all sales of fodder by farmers took place in the village, as it was difficult for farmers to transport their fodder to a market.

Producers' perceptions about fodder quality

An attempt was made to assess farmer perceptions of fodder quality. From a list of attributes, chopped short-length straw was the most desired for all the main fodders (paddy, wheat and pulses). Bright colour was the second important attribute for wheat straw but it was the fourth important attribute for paddy and pulse straws. Purity of fodder—that is, being free from contamination with other fodder species or varieties—emerged as the second most important attribute for pulse straw and third important for wheat and paddy straw. Farmers did not consider variety as an important attribute. Hence, short length, bright colour and purity are the important quality attributes. Taste was the least important attribute. Even when choosing cereal varieties to grow for human consumption, farmers do not consider taste: important criteria for selection of rice varieties in Bihar, for example, are yield and duration of crop (Singh, Thakur and Thelma, 2000).

Concentrate production

Feed millers produce small quantities of concentrates. Average annual concentrate production was about 87.4 t per miller in the surplus zone, whereas in the deficit zone, each miller produced only 15.2 t per year on average. Mustard and oil seed cake were the major concentrates and jointly constituted 53% of concentrate produced by feed millers, whereas maize-based feed was the third important feed (27%) produced by these millers.

Millers produced small quantities of *choker* (husks of wheat grain) and *darra* (crushed grains) from food grains. Raw materials purchased by concentrate millers can be grouped into two categories: those exclusively for feed production (e.g. maize, barley and pulses and those for dual purpose feed and food (e.g. wheat, mustard and linseed). Wheat is used for production of flour, *chokar* and *darra* whereas mustard and linseed are used for production of oils and cakes (feed). Raw materials for feed production appeared to be readily available to millers since they bought more than two-thirds of their requirements at their business premises, mainly supplied by farmers and vendors. The other third was bought from wholesalers, indicating an important role of wholesalers in the supply of raw materials to feed millers in Bihar. Small feed millers had, on an average, a turnover of about Rs. 1.4 million, with oil cake accounting for about 58 percent of total business. The price of concentrates varied from Rs. 18.54/kg for linseed cake to Rs 8.17 for maize *darra*. Among *darra*, that from pulses was the most expensive (Rs. 14.04/kg).

Concentrate millers sold all their output at their business premises. They sold about 65 percent directly to consumers (farmers and dairy producers) with retailers as the second most important buyers. Thus concentrates produced by unorganized millers do not pass through long marketing channels with different intermediaries such as vendor and wholesalers.

Sales of concentrate (mainly crushed milled grains) were higher in summer season when green fodder is in short supply and availability of raw material is higher because it is just after harvesting of rabi crops. Sales are lower in autumn season due to an abundance of green fodders, including cut grasses.

Fodder and concentrate marketing

The market for dry and green fodders in Bihar is extremely underdeveloped and highly informal. However, there is a distinct pattern of fodder marketing between the fodder surplus and deficit zones. In fodder surplus zones, the main traded fodder is paddy straw. In these zones, an average trader buys 143 t of dry fodder per year, of which about 136 t (95%) is paddy straw.

The scenario, however, is quite different in the fodder deficit zones. Paddy straw as a fodder is least preferred and is only fed to livestock when farmers do not have any alternative. About 89% of the dry fodder traded in deficit zones was wheat straw because it is supposed to be more palatable and nutritious. It also appeared that 53% of traded fodder passes through wholesalers in the deficit zone compared to 30% in the surplus zone.

The role of retail traders in fodder marketing appeared to be quite significant and critical. On average, retail fodder traders buy and sell more fodder than an average wholesaler. About 42% of

the fodder being traded passed through retailers. Retail traders purchased about 118 t of dry fodder per annum, maintaining about 10% of that as running stock.

The function of vendors was also important. They normally collect or buy small quantities of fodder from producers and sell it in nearby markets to dairy producers, semi-processors, wholesalers and retailers. In urban areas, they also buy fodder from retail traders. Vendors usually prefer to dispose off their fodder stock the same day.

Fodder processing, sorting, grading and storage by traders

About one quarter of the vendors, one third of the retailers and half of the wholesalers in Bihar store fodder. It is a common practice for traders to purchase fodder from producers, but to not take delivery of the entire lot at once. Instead, they store fodder in the farmers' yards and take delivery of it gradually as and when required. A small proportion of the fodder purchased is also stored at the business premises or houses of the traders.

As far as processing is concerned, about 41% of traders processed fodder in some way, with different forms of processing characterizing the deficit and surplus zones. Traders in the deficit zone did little processing. Some retailers (9%) did go for light processing like chopping of maize stover, etc., but in general fodder was sold without any additional processing. It is important to recall that wheat straw is the main marketed fodder in the deficit zone and it is automatically chopped into small pieces during harvesting by the threshers using combine harvesters or specially designed threshers. In contrast, paddy straw, which dominates the fodder markets in the surplus zone, is harvested and threshed manually by beating or hitting the small bundles (*antia*) of paddy. Therefore, paddy straw must still be chopped into small pieces before feeding. Chopped paddy straw fetches a higher price and hence almost all retailers and wholesalers chopped paddy straw before selling. Many vendors (42%) in the surplus zone also chopped paddy straw before selling it. No other forms of processing such as preparation of silage, fodder bricks, urea treatment, etc. were reported.

Traders' perceptions about fodder quality

Certain quality parameters are important in fodder trade. Although there are no hard and fast rules, there are a number of parameters that traders report keeping in mind. Colour, size, moisture, softness, purity, cleanliness and variety are some of the parameters which are taken into account during negotiation and price determination. Sensory methods are mainly used to assess these quality attributes. The majority of traders take account of colour before buying. Usually, fodder having uniform colour and bright lustre is preferred. Most traders (78%) reported that a natural colour of fodder was the prime consideration when buying with length/size of the fodder being the next important consideration. For wheat straw and chopped paddy straw, traders preferred finely chopped small pieces because consumers also prefer chopped straw. Purity--defined as fodder not being mixed with other fodder species or varieties—also was important. These quality parameters are considered because consumers also accord highest priority to them. About 93% of consumers bought fodder after observing the colour. Purity of fodder was also important and 6% of traders stated that they tried to convince buyers about the purity and cleanliness of the fodder while selling.

Price trends of important fodders

Fodder prices appear to be highly volatile, probably because of variation in demand and supply in the state. Frequent droughts and floods or the combination (drought followed by the flood) are regular features in many parts of the state and greatly affect production and availability of fodder which ultimately governs price. Besides year-to-year variation in fodder prices, intra year price differential is also common. Table 3.1 presents the maximum and minimum prices of fodder for the three years since 2006. It is obvious that based on these trends, projecting future prices is extremely difficult.

Table 3.1: Annual variation in price of different types of fodder (Rs./kg)

Type of fodder	Surplus-zone						Deficit-zone						Overall					
	2008		2007		2006		2008		2007		2006		2008		2007		2006	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Wheat straw	2.41	1.74	2.42	1.67	1.98	1.59	2.95	1.78	5.63	2.40	3.01	1.64	2.81	1.77	4.78	2.21	2.75	1.63
Paddy straw	2.55	2.03	2.28	1.74	1.95	1.55	2.27	1.62	3.67	2.10	2.36	1.53	2.47	1.92	2.67	1.84	2.08	1.54
Pulse straw (lentil)	3.00	2.00	3.00	2.00	2.50	1.50	.	.	.	.	.	.	3.00	2.00	3.00	2.00	2.50	1.50
Pulse straw (lathyrus)	3.50	2.00	3.50	2.00	2.50	1.50	.	.	.	.	.	.	3.50	2.00	3.50	2.00	2.50	1.50
Pulse straw (gram)	3.00	2.00	3.00	1.50	2.50	1.25	.	.	.	.	.	.	3.00	2.00	3.00	1.50	2.50	1.25
Maize stover-green	.	.	.	.	.	.	4.00	3.50	5.50	4.00	4.00	3.00	4.00	3.50	5.50	4.00	4.00	3.00

Concentrate marketing

In Bihar, feed companies and millers are the largest sellers of concentrates. In the deficit and surplus zones, about 66 and 43%, respectively, of concentrates are purchased by traders from feed companies and millers. Concentrate traders supply these to farmers and dairy producers and in some cases to other concentrate traders.

Wholesalers are other important players, selling 42% in the surplus zone and 28% in the deficit zone directly to other concentrate traders. Some farmers are also involved in concentrate trading, accounting for about 4% of concentrates traded. In the surplus zone, vendors sold about 11 percent of concentrates to concentrate traders, mostly degraded grains, pulses etc. for resale as feed concentrates. In contrast, in the deficit zone, vendors did not play any role in concentrate marketing.

About 69% of concentrates purchased by concentrate traders in the surplus zone was purchased on credit as compared to only 2% in the deficit zone. Cash purchases accounted for 28% in the deficit zone and another 32% was obtained by making partial payment in cash and the rest on credit. Interestingly, 39% of concentrate was purchased by making payment in advance in the deficit zone. Thus the supply-demand scenario appears to have a big influence on the mode of transaction financing.

Oilseed cakes, small broken pieces of pulses (*chunni*), crushed grains (*darra*), other coarse grains, manufactured compound animal feed, and seeds of leguminous weed (locally known as *akta misiya*)

were the principal concentrates reported sold and purchased in Bihar (Table 3.2). During autumn, sales of concentrates are at their lowest level, while in winter they are highest (mainly oilseed cakes and compound feed). Autumn is the lean season for dairy production when a majority of dairy animals become dry and thus producers only provide them maintenance levels of feeding. The energy requirement of animals increases in winter, increasing the demand for concentrates.

Table 3.2: Trade volume and purchase and sale prices of various concentrates

	Surplus zone			Deficit zone			Overall		
	Quantity (t/trader/ year)	Purchase price (Rs./kg)	Sell price (Rs./kg)	Quantity (t/trader/ year)	Purchase price (Rs./kg)	Sell price (Rs./kg)	Quantity (t/trader/ year)	Purchase price (Rs./kg)	Sell price (Rs./kg)
Linseed cake	11.9	17.1	18.8	5.6	17.3	19.1	8.7	17.1	18.9
Mustard cake	25.6	11.5	12.7	6.5	10.3	11.5	16.0	11.2	12.4
Other cake	0.0	0.0	0.0	1.1	10.9	12.2	0.5	10.9	12.2
Chokar (husk)	69.8	8.0	8.8	5.2	6.6	7.5	37.5	7.9	8.8
Chunni (pulses)	8.4	7.4	8.9	1.1	13.6	13.9	4.8	8.1	9.5
Darra (wheat)	19.0	9.2	10.4	7.1	6.9	7.9	13.0	8.6	9.7
Darra (maize)	33.7	7.3	8.4	5.2	6.9	8.5	19.5	7.3	8.4
Darra (other)	6.9	8.0	9.0	0.1	9.0	10.0	3.5	8.0	9.0
Compound feed	57.5	7.3	8.5	255.7	8.3	9.0	156.6	8.2	8.9
Mineral mixture	0.0	0.0	0.0	0.4	6.3	7.7	0.2	6.3	7.7
Akta Misiya	0.8	14.1	15.0	0.8	11.5	12.8	0.8	12.8	13.9
All	233.4	8.7	9.8	288.9	8.5	9.3	261.1	8.6	9.5

Fodder and concentrate consumption

Characteristics of feed consumers

Livestock holdings can be broadly categorized into three groups; urban commercial dairy, rural commercial dairy and rural smallholder dairy. They are the main buyers of fodder, with their demand for fodder varying according to the number of animals owned. Commercial dairies in urban and rural areas of the deficit zone had larger herds compared to their counterparts in the surplus zone, although the proportion of dry animals was larger in the deficit zone. Urban commercial dairies in both zones had similar proportions of crossbred cattle in their herds, but the proportion of buffalo was higher in the surplus zone. In both zones, the herd size in rural dairy farms was small with about 50% of the animals being dry (Table 3.3).

Fodder and concentrate purchase

All categories of dairy farms in the surplus zone and urban commercial dairy farms in the deficit zone used paddy and wheat straw as the principal dry fodder. Pulse straw constituted less than 5% of total dry fodder used by dairy farms in the surplus zone and less than 2% on rural dairy farms in the deficit zone. Since the deficit zone is a maize growing area, rural commercial dairy farms there used a substantial quantity of maize stover. All maize stover in the deficit zone was not used as fodder because a substantial quantity was used either as fuel, particularly by poor households, or burned in the field.

Table 3.3: Livestock holdings of different types of consumers (in Tropical Livestock Units [TLU])

	Surplus zone			Deficit zone			Overall		
	Urban commer-cial dairy producer	Rural commer-cial dairy producer	Rural other farmers	Urban commer-cial dairy producer	Rural commer-cial dairy producer	Rural other farmers	Urban commer-cial dairy producer	Rural commer-cial dairy producer	Rural other farmers
Herdsize	**11.1**	**3.9**	**3.2**	**19.3**	**4.3**	**2.3**	**15.2**	**4.1**	**2.8**
Indigenous Cattle	0.7	1.3	1.6	2.9	1.4	1.5	1.8	1.4	1.6
Crossbreed Cattle	5.0	1.2	0.6	13.2	0.5	0.3	9.1	0.9	0.4
Indigenous Buffalo	5.2	1.4	0.9	1.7	2.2	0.4	3.4	1.8	0.7
Improved Buffalo	0.3	0.0	0.0	1.4	0.0	0.1	0.8	0.0	0.0
Adult dairy animals	**9.1**	**2.5**	**1.7**	**15.0**	**2.5**	**1.0**	**12.1**	**2.5**	**1.3**
In milk	7.0	2.0	0.9	9.5	1.5	0.5	8.3	1.8	0.7
Dry	2.2	0.5	0.8	5.5	1.0	0.5	3.8	0.7	0.7

Berseem, green oats, cut grass and maize are the main green fodders in Bihar, with berseem being the main green fodder in the surplus zone and maize in the deficit zone. Agriculture in the surplus zone is more developed and has improved irrigation infrastructure for production of berseem. Maize is an important crop in the deficit zone and it is one of the important green fodders. Cut grass was an important green fodder on rural commercial dairy units in both zones, mainly due to easy access. Oats was also used as fodder, particularly in the deficit zone but not in the surplus zone. In the deficit zone, oats are grown as a green fodder crop prior to growing early summer vegetables. Bamboo leaves are also fed as green fodder in the deficit zone.

Rural commercial dairy units in both zones mainly buy fodder directly from farmers. Urban commercial dairy units in the surplus zone buy fodder mainly from retailers (43%) and vendors (29%). In the deficit zone, vendors are also important suppliers of fodder (49%) for urban commercial units which also purchased fodder from farmers (41%). Wholesalers were not an important source of fodder for commercial dairy units; they operate as middlemen in the fodder marketing chain.

It is worth pointing out that urban commercial dairy units in the deficit zone bought about twice the quantity of concentrate (3.3 kg/Tropical Livestock Unit (TLU) /day) than their counterparts in the surplus zone (1.6 kg/TLU/day). Rural commercial dairy units and rural smallholder dairy farms in the deficit zone also bought less concentrate than urban commercial dairy units in the zone, but more than their counterparts in the surplus zone. The higher use of concentrate by all categories of dairy units in the deficit zone may reflect the scarcity of green fodder.

There was a small difference in the price of major concentrates purchased by different categories of dairy units. In the surplus zone, urban dairy units paid higher prices for concentrates than rural commercial dairy units and rural smallholder dairy farms.

Consumer feed use

Feed consumers combined individual feeds to make various rations. The resulting consumption patterns differed considerably between consumer types. About 5.6 kg dry fodder, 0.3 kg green fodder and 2.7 kg concentrates were used per day per TLU by urban commercial dairy producers, whereas rural commercial dairy producers fed 5.0, 1.0 and 0.7 kg and rural farmers fed 6.0, 1.1 and 0.5 kg of dry fodder, green fodder and concentrates per day per TLU (Table 3.4). Among different types of concentrates used on surveyed dairy units, oil cakes, *choker-chunni*-husks, and milled grains constituted more than four-fifths of total concentrates consumed in both zones. Compound feed was more popular in the surplus zone, but urban commercial units in the deficit zone also used more compound feed (0.6 kg) for milk production than their counterparts in the surplus zone (0.1 kg). Feeding a mineral mixture was not common.

Table 3.4: Fodder and concentrate consumption per day per TLU and share by individual feed

	Surplus zone			Deficit zone			Overall		
	Urban commercial dairy producer	Rural commercial dairy producer	Rural other farmers	Urban commercial dairy producer	Rural commercial dairy producer	Rural other farmers	Urban commercial dairy producer	Rural commercial dairy producer	Rural other farmers
Dry fodder (kg DM/day/TLU)	6.0	5.4	6.3	5.5	4.4	5.6	5.6	5.0	6.0
% of total dry fodder									
Wheat straw	26.7	55.5	39.0	90.6	44.8	52.5	65.9	51.0	44.3
Paddy straw	68.1	40.3	55.9	8.8	27.3	40.2	31.7	34.8	49.7
Maize stover	0.0	0.9	0.5	0.6	26.5	4.7	0.4	11.7	2.1
Pulse straw	5.1	3.0	2.8	0.0	0.7	1.0	2.0	2.0	2.1
Other dry fodder	0.0	0.3	1.8	0.0	0.8	1.6	0.0	0.5	1.7
Green fodder (kg DM/day/TLU)	0.28	0.87	0.96	0.33	1.12	1.25	0.32	0.99	1.08
% of total green fodder									
Berseem	44.9	19.9	35.9	14.1	0.7	4.6	24.2	9.6	20.6
Oat straw-green	6.0	0.0	0.2	12.9	8.4	6.4	10.6	4.5	3.2
Maize stover-green	0.0	4.1	1.2	23.5	17.3	7.8	15.8	11.2	4.4
Sugarcane top-green	0.0	2.5	2.9	0.0	3.8	3.1	0.0	3.2	3.0
Cut grass-green	11.9	52.8	38.3	29.2	54.0	56.4	23.5	53.5	47.1
Bamboo leaf-green	0.0	0.3	0.5	9.9	8.7	14.3	6.7	4.8	7.3
Sudan - green	7.2	0.8	1.4	5.8	6.9	3.9	6.3	4.1	2.6
Other green fodder	30.1	19.6	19.6	4.6	0.2	3.5	13.0	9.2	11.7
Concentrate (kg/day/TLU)	1.6	0.6	0.4	3.3	0.8	0.6	2.7	0.7	0.5
% of total concentrate									
Oil cakes	16.4	29.6	37.1	8.1	7.2	13.1	9.9	18.0	25.0
Chokar, chunni and husks	41.5	17.0	20.7	23.2	41.6	25.6	27.3	29.8	23.2
Crushed/milled grains	36.2	33.2	28.7	48.2	46.5	55.9	45.5	40.1	42.4
Compound feed	5.5	20.2	13.4	19.2	4.2	5.1	16.1	11.9	9.2
Mineral mixture	0.0	0.0	0.1	1.0	0.0	0.1	0.8	0.0	0.1
Other concentrate	0.3	0.0	0.0	0.4	0.5	0.1	0.4	0.2	0.1

In the surplus zone, urban commercial dairy units used comparatively large quantities of "*choker-chunni*-husk" followed by milled grains, oil cakes and compound feed, whereas rural commercial dairy units used more milled grains followed by compound feed, *choker-chunni*-husk and oil cakes.

Rural smallholder dairy farms had different patterns of concentrate feeding; on these units, more oil cake was used followed by milled grains, *choker-chunni*-husks and compound feed. In the deficit zone also, there was inter-category variations in concentrate feeding patterns, but the seasonal pattern was identical for all categories of dairy units.

3.3. Conclusions

State government intervention in fodder production and marketing is non-existent in Bihar. However, the government arranges to supply dry fodder and provides transportation support during floods. Fodder production and marketing does not feature in the '*Road Map for Agriculture and Allied Sectors'* by the Government of Bihar, nor does fodder marketing feature in any dairy development programmes in the state. The main issues that emerge from the study are:

1. There is no specified place for fodder marketing, hence, a market place for fodder could be arranged by the government in existing market yards where sufficient unutilized space is available for this purpose.
2. Within villages, more than 80% of trade in fodder is direct to consumers and the price of fodder is high in the deficit zone.
3. Seasonal price fluctuations reflect the lack of storage capacity at producer, trader and consumer levels.
4. Urban dairy producers are major buyers of fodder; they buy about 73% of dry fodder sold by traders.
5. The type of fodder used also depends on the intensity of production: with increasing intensification of dairy production, the share of wheat straw being fed to dairy animals increases.

4. Fodder quality

4.1. Rationale of including quality aspects in the study

Product definition and differentiation is an important aspect in most studies of markets. However, in the case of the few previous studies of straw markets, the level of detail paid to product definition and quality is generally limited. In most reports, straw is only defined by crop species and, in a few cases, variety groups are considered where differences within a crop are especially strong, for instance within rice.

However, it is known that the nutritional quality of cereal straw varies greatly within crops as well as between crops. A considerable part of this variation is genetically based. This raises several questions:

- What is the actual variation in nutritional quality found at various stages of the straw marketing chain?
- How is the variation in quality perceived by consumers and traders of straw?
- How far do consumers and traders differentiate between environmental (e.g. management related) and genetic (e.g. varietal) effects on quality of straw? How is this knowledge carried along the marketing chain?
- What does this mean for improvement strategies, both through management and breeding approaches?

Thus, the component on quality of straw throughout the marketing chain was designed as an integral part of the study. An important aspect regarding the evaluation of quality is the link between prices and various quality attributes. Information on prices and quality was collected from large urban markets to investigate price determinants. In these markets, large quantities of straw are traded by specialised traders who have often been involved in the trade for many years. Thus, it is assumed that prices here are less volatile than in smaller markets and that the traders have acquired a substantial amount of knowledge.

4.2. Materials and methods

To answer the questions raised above, the following data were collected:

- perceptions of traders on straw quality and its components
- prices
- nutritional quality determined by laboratory analysis

In addition, data on market structure and linkages were collected to enable links to the other components of the study. Because another project was also working on issues of straw marketing at New Delhi and Kolkata, it was possible to conduct the same data collection routine at all three sites (Figure 4.1), allowing for insights into possible site effects on prices and quality perceptions.

In Bihar, both wheat and rice straw is widely fed and is therefore also traded in Patna. In New Delhi, only wheat straw is traded, while in Kolkata, only rice straw is found in fodder markets. This report will focus on the findings in Patna, but for comparison some results from New Delhi and Kolkata are also shown.

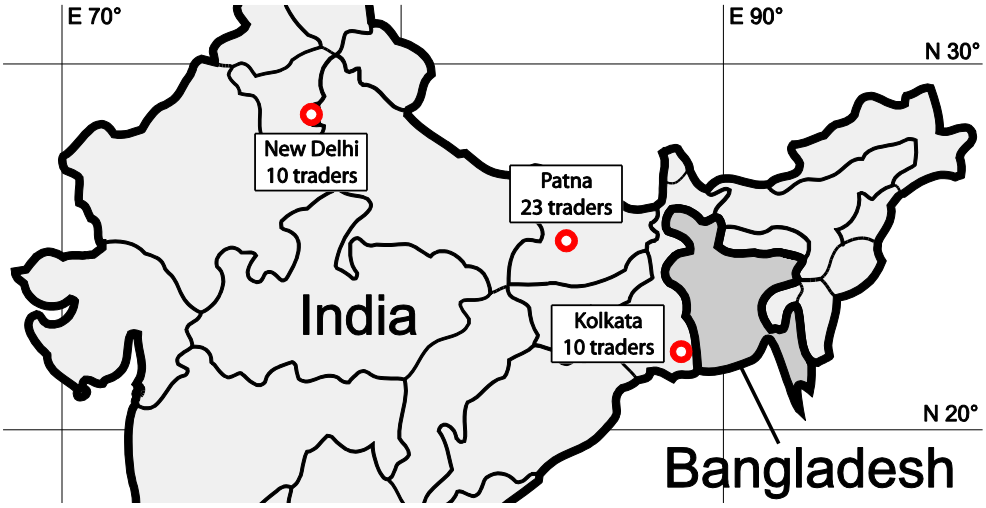

Figure 4.1: Location of sampling sites

The aim was to collect data from specialised fodder traders on specific straw qualities, the main unit of analysis, at monthly intervals over the course of 13 months. Thus, 12 wheat straw samples and 12 rice straw samples were collected in Patna monthly over 13 months. Concurrently, 12 monthly samples over 13 months were collected in New Delhi (wheat straw) and Kolkata (rice straw). The sampling included completion of a one-page questionnaire for each sample which recorded quality perceptions, price and market chain information (Figure 4.2).

The major sampling step involved selecting the fodder traders from which the straw samples were then collected. They were selected following these criteria:

- Traders were well established to ensure that they would be trading for the coming year (Figure 4.3)
- Fodder traders were located in at least two fodder markets per site to control for a market effect.
- At least three traders from each market were included.
- If possible, traders were offering more than one quality throughout the year.
- If possible, traders from Patna were trading both wheat and rice straw.
- When trading rice straw, it should be offered as chopped straw to customers, even though it is often transported unchopped (Figure 4.4)

Where a trader was selling more than two feed-grade qualities, only the highest and lowest priced qualities were sampled. However, most traders were only trading one quality and only one straw type. Thus, a considerable number of traders were selected from each site. Table 4.1 shows the location of the selected traders at the Patna site. In addition to the data collected for each sample, information on the traders was collected during two visits, to allow for control of trader characteristics (Figure 4.4). Finally, traders were asked to grade three common samples to enable the comparison of trader perceptions.

Figure 4.2: Sampling interview

Figure 4.3: Urban wheat straw trader in Patna

Figure 4.4: Large paddy straw bundles

Table 4.1: Location of sampled fodder traders in Patna

Locality	Market name	No of selected traders
Hajipur	Andarkilla	2
Hajipur	Anjanpur	2
Hajipur	Zadhua	5
Patna	Babu Bazar	1
Patna	Hanuman Nagar, Kankarbag, Jogipur	2
Patna	Harnichak, Mitramandal Colony	5
Patna	Mahabir Colony, Mithapur	2
Patna	Jagdev Path	3
Patna	Tulsi Mandi, Sudarshan Path	1

During each sampling visit, the selected straw traders were asked to evaluate the quality of each sample according to six characteristics which had previously been identified as the most important: shortness of particles, softness, purity, brightness, dryness and taste. In addition, rice straw, which was delivered to traders unchopped, was also evaluated by the criteria of length, thinness and brightness of colour at base. Finally, an overall assessment of the quality was recorded. Traders were asked to assign index values ranging from 1 (e.g. best, shortest, brightest …) to 5 (e.g. poorest, longest, least bright …).

In order to increase the accuracy of the laboratory results, four replicates were collected for each sample. At the ILRI facility in Hyderabad, these samples were first dried and weighed to determine the dry-matter content. They were then ground through a 1mm sieve and subjected to Near Infrared Spectrometry (NIRS) which uses near-infrared light rays and records the absorption/reflection spectrum. The resulting data were processed with regression equations which had been calibrated during previous studies by conventional laboratory methods.

The following variables were generated for characterising nutritional quality: ash content [%], silica (only rice straw) [%], nitrogen content (n-dm) [%], neutral detergent fibre (ndf) [%], acid detergent fibre (adf) [%], acid detergent lignin (adl)[%], digestibility [%], and metabolisable energy (ME) [kJ/kg].

For investigating links between variable groups, ordinary least squares regression was employed. In the case of the price determinants, variables were first screened by an ANOVA in order to avoid flooding the regression model with insignificant variables. A squared month term was introduced to account for the assumed cyclical pattern of seasonal effects.

4.3. Results

This section focuses on the results of the quality perceptions, the nutritional analysis and prices. All three variable groups show considerable seasonal variation. Therefore, descriptive means are presented over the course of the data collection period. In order to better understand links between variables, the results of simple regression analyses are also presented.

Perceived quality traits

Table 4.2 shows the seasonal variation of the overall assessment as well as the results for shortness, brightness and softness. These variables are generally regarded as most important by the traders.

Table 4.2: Seasonal variation of the perceived quality index of wheat and rice straw, overall and selected quality components

	Months in 2008							Months in 2009					
	06	07	08	09	10	11	12	01	02	03	04	05	06
Wheat straw													
Overall	1.67	1.83	1.33	1.67	2.00	2.08	2.08	1.75	2.08	2.00	2.00	2.42	2.17
	(0.78)	(0.72)	(0.49)	(0.65)	(0.74)	(0.90)	(0.67)	(0.45)	(0.79)	(0.74)	(0.85)	(0.67)	(0.83)
Short	2.08	1.64	1.25	1.50	1.75	1.83	1.83	1.75	1.83	1.58	1.83	2.25	2.08
	(1.08)	(0.50)	(0.45)	(0.52)	(0.62)	(0.83)	(0.39)	(0.45)	(0.58)	(0.51)	(0.58)	(0.75)	(0.67)
Bright	2.25	1.83	1.58	1.75	2.17	2.00	1.58	1.67	1.75	1.75	1.42	1.92	1.92
	(0.97)	(0.83)	(0.51)	(0.75)	(0.72)	(0.60)	(0.51)	(0.49)	(0.45)	(0.62)	(0.51)	(0.90)	(0.51)
Soft	2.25	1.58	1.33	1.50	1.50	1.58	1.58	1.17	1.33	1.42	1.83	1.83	1.83
	(1.06)	(0.67)	(0.49)	(0.52)	(0.67)	(0.67)	(0.67)	(0.39)	(0.49)	(0.51)	(0.58)	(0.72)	(0.72)
Rice straw													
Overall	1.75	2.36	2.42	1.67	1.58	2.00	1.92	1.83	2.80	2.08	2.25	2.00	2.25
	(0.62)	(0.67)	(0.51)	(0.78)	(0.51)	(0.43)	(0.67)	(0.39)	(0.92)	(0.29)	(0.45)	(0.71)	(0.87)
Short	1.50	1.27	1.83	2.00	2.00	2.00	1.92	2.00	2.00	2.00	2.00	2.00	2.00
	(0.52)	(0.47)	(0.39)	(0.00)	(0.00)	(0.00)	(0.29)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Bright	2.42	3.09	2.58	1.42	1.50	2.08	1.67	1.42	2.00	1.83	2.00	1.67	1.83
	(0.79)	(1.14)	(0.67)	(0.67)	(0.52)	(0.51)	(0.49)	(0.51)	(1.15)	(0.58)	(0.43)	(0.71)	(0.72)
Soft	2.00	2.45	2.00	1.58	1.00	1.50	1.50	1.42	1.90	2.42	2.33	2.78	2.00
	(0.60)	(0.69)	(0.74)	(0.67)	(0.00)	(0.52)	(0.52)	(0.51)	(0.74)	(1.08)	(0.49)	(0.67)	(0.74)

Figures in the parentheses are standard deviations

Data source: 12 monthly samples from Patna; the index values range from 1 (best) to 5 (poorest)

In order to test for the consistency of evaluation, the effect of the quality traits on the overall quality perception is estimated through a regression analysis. The resulting coefficients are shown in Table 4.3.

Table 4.3: Contribution of perceived quality components to the overall quality index

dep. variable: overall quality	wheat (n=2941, adj r^2: 0.659)		paddy (n=274, adj r^2: 0.536)	
	stand. beta	significance	stand. beta	significance
(constant)	-	.888	-	.515
Short	.387	.000	.105	.019
Soft	.182	.000	.135	.004
Pure	.077	.069	-.129	.016
Bright	.241	.000	.276	.000
Dry	.001	.976	-.067	.163
Tasty	.197	.000	.341	.000
long (whole)	-	-	.090	.033
thin (whole)	-	-	.157	.001
basebright (whole)	-	-	.193	.000

[1] data source: samples from New Delhi, Patna and Kolkata

Nutritional quality

Of the nine variables determined by the NIRS procedure to characterise the nutritional quality of the collected straw samples, only the results of the three most indicative variables are presented here. Digestibility is often the first major constraint in feed quality, nitrogen content indicates the proportion of leafy material and metabolisable energy is often the most limiting constraint from a feeding perspective. The seasonal variation of these variables is presented in Table 4.4.

Table 4.4: Nutritional quality of straw samples

	Months in 2008							Months in 2009					
	06	07	08	09	10	11	12	01	02	03	04	05	06
Wheat straw													
ivo[1] [%]	44.09	47.39	46.43	46.13	45.38	45.39	46.41	45.56	46.06	47.13	47.87	47.41	47.02
nitrogen[2] [%]	0.65	0.73	0.70	0.72	0.76	0.77	0.75	0.70	0.73	0.59	0.63	0.70	0.93
ME[3] [MJ/kg]	6.36	6.81	6.79	6.64	6.60	6.76	6.64	6.75	6.90	7.01	6.92	6.86	5.94
Rice straw													
ivo [%]	43.74	38.82	39.36	39.26	37.74	38.74	39.82	40.37	39.46	39.34	41.02	40.23	41.01
nitrogen [%]	0.93	0.84	0.71	0.71	0.73	0.68	0.60	0.68	0.66	0.65	0.81	0.84	0.88
ME [MJ/kg]	5.94	5.11	5.60	5.53	5.62	5.88	5.83	5.78	5.66	5.62	5.37	5.30	5.49

[1] ivo: in-vitro digestibility, [2] nitrogen: nitrogen content in dry matter, [3] ME: metabolisable energy

Data source: 12 samples of wheat and rice straw each for each month from Patna

Straw prices

Sale prices collected from the straw traders during the data collection period are listed in Table 4.5. Although actual prices often include delivery and some credit arrangement as additional services by the trader to the customer, the prices listed here include neither. For comparison, the prices from New Delhi and Kolkata are included in addition to those from Patna.

Table 4.5: Prices of wheat and rice straw from three sites (Rs/kg)

	Months in 2008							Months in 2009					
	06	07	08	09	10	11	12	01	02	03	04	05	06
Wheat straw													
Patna	2.96	3.59	3.73	3.52	3.48	3.27	2.96	3.10	2.88	2.69	2.31	2.60	2.85
New Delhi	3.40	3.68	3.76	3.81	3.88	4.01	3.80	4.29	5.03	5.01	4.13	4.40	4.94
Rice straw													
Patna	2.73	3.13	2.95	2.94	3.00	2.83	2.77	2.63	2.25	2.08	2.06	2.06	2.08
Kolkata	3.13	3.23	3.25	3.27	3.44	3.21	3.35	3.02	3.13	2.98	3.30	3.29	3.42

Data source: 12 samples for each month from each site and type

Links between traits, nutritional quality and price

In order to better understand the links between quality perceptions, market prices and nutritional quality, various regression analyses were performed. Only selected results are presented here. Table

4.6 shows the effects of all perceived quality traits on the dependent variable "price". The low r^2 value in the case of wheat indicates how little of the price variation can be explained by the perceived quality traits. On the other hand, some traits, especially "thinness (whole)" and "purity" appear to contribute to higher prices. It should be investigated further why "brightness" and "dryness" show a positive sign, indicating poorer quality for these attributes correlates with higher prices.

Table 4.6: Effects of perceived quality traits on straw price

dep. variable: price [Rs/kg]	wheat (n=294, adj r^2: 0.093)		paddy (n=272, adj r^2: 0.288)	
	stand. beta	significance	stand. beta	significance
(constant)	-	.000	-	.000
Short	-.012	.856	-.057	.306
Soft	-.156	.026	-.030	.599
Pure	-.301	.000	-.176	.008
Bright	.159	.022	.245	.001
Dry	-.064	.293	.278	.000
Tasty	.094	.227	-.178	.010
long (whole)	-	-	-.050	.339
thin (whole)	-	-	-.429	.000
basebright (whole)	-	-	.016	.787

Data source: all complete sample records from Patna, New Delhi and Kolkata

Subsequently, the links between the perceived quality traits and nutritional quality were investigated. However, it is not possible to determine effects of the perceived quality traits on digestibility through this regression analysis. The regression model for wheat straw only shows a significance level of 0.248, while the regression model for rice straw is significant but only exhibits an adjusted R^2 of 0.030.

Similarly, regression results do not indicate any effects of perceived traits on metabolisable energy content. For wheat straw the model significance is 0.572, while for rice straw the model is once again significant but the adjusted R^2 is only 0.140. The single coefficient with a reasonable significance is "dryness".

Finally, both quality traits and nutritional variables are included in a regression analysis together with environmental variables to investigate price determinants. The resulting coefficients are shown in Table 4.7.

Table 4.7: Determinants of straw price

dep. variable: price [Rs/kg]	wheat (n=317, adj r^2: 0.459)		paddy (n=275, adj r^2: 0.458)	
	stand. Beta	significance	stand. beta	significance
(constant)		.482		.000
month	-.069	.738	.226	.307
month square	.068	.709	-.354	.087
year	.060	.442	-.414	.000
city	-.671	.000	-.562	.000
digestibility	-.233	.130		
metab. energy	.191	.212		
short			-.105	.035
soft			-.025	.647
tasty			-.108	.066
thin (whole)			-.170	.002
overall quality			-.090	.145

Data source: all complete sample records from Patna, New Delhi and Kolkata

4.4. Discussion and Conclusions

Discussion

The overall design of the study proved to be effective in collecting and analysing the desired data. The traders were happy to co-operate and the information provided seemed sufficiently consistent. One lesson that emerged was the need to accurately define prices as traders varied in the extent of additional services they routinely provided.

During data collection, it was observed that traders did not use a wide range of index values to evaluate their straw. The values generally varied between 1 and 3, which is also apparent in the low standard deviations shown in Table 4.2. In addition, as most traders only traded in one quality, the trader effect in the evaluation procedure was fairly large. In fact, some traders who were generally selling cheaper straw were often insistent on giving their straw high marks ("I sell only the best quality!"). Thus, in future studies such evaluations might be performed by an external person in order to avoid such a bias. For testing the trader effect, traders were asked to evaluate three standard samples. The data of this exercise are not yet analysed.

The results of the quality perceptions show some variation through the seasons, but this is not easy to interpret. For instance, the overall quality of wheat straw is generally perceived to be the highest in August, four months after harvest and at the height of the monsoon season. Generally, high levels of humidity lead to a deterioration of straw quality. Also, the value levels do not differ greatly between the variables.

Nevertheless, the regression of overall quality by the quality traits shows a useful explanatory power. In wheat, shortness and brightness show the greatest contribution while tastiness and softness are also significant, albeit with lower coefficient values. In rice, tastiness even shows the greatest contribution while colour, for both chopped and unchopped straw, is also important.

Tastiness is somewhat difficult to define and quantify. On the other hand, the colour of straw is probably influenced considerably by fungus infestation, which occurs especially in humid periods.

The type of quality variables also indicates that for consumers and traders, straw quality is foremost determined by various processing and management characteristics. For instance, shortness and softness is mainly influenced by the type of thresher employed. On the other hand, colour, dryness and purity are probably controlled largely by storage and transport. So far, intervention approaches have been mainly aimed at genetic improvements through varietal selection for superior nutritional quality, based on the fact that existing varieties show a wide variation in these characteristics. However, in the studied urban markets, traders were never aware of the varietal origin of their straw. They were, however, aware of differences in nutritional quality of varieties.

The results of the nutritional analysis show a fairly consistent picture. Only the first month (June 2008) appears to be an outlier with relatively low values for wheat and high values for rice. It is noteworthy that the digestibility values for rice are generally lower than the average of all rice varieties previously tested, which was above 40%. It would be interesting to investigate this further to determine whether this is caused by variety choice, agronomic practices or post-harvest characteristics. In general, straw quality was highest around harvest time (March/April for wheat and November/December for rice). However, digestibility in rice appears to be highest six months after the harvest.

The results of price recording indicate that seasonal factors alone do not determine prices. For instance, although wheat straw in Patna is cheapest after harvest in April, the peak price is found in August 2008. In New Delhi, prices in 2009 appear to be considerably higher than in 2008. And rice straw in Patna is cheapest in April/May, four months after harvest. Also, the difference in prices between sites is greater than between straw types within Patna. In fact, wheat and rice straw prices in Patna appear to move in parallel, with their peak in August (wheat) / July (rice) and their lowest values in April. This indicates a fair degree of substitutability, which is consistent with reports from the data collection. It would be interesting to investigate how the comparative evaluation of wheat and rice straw in Patna differs between various types of consumers.

The various regression analyses regarding straw prices confirm the earlier indication of complex relationships existing between variables. Neither quality traits nor nutritional quality variables alone can explain straw prices. The only exception might be the quality traits of rice straw with close to 30% explanatory power, where “thinness of the whole straw” provides a large and significant contribution to price variation while having the expected negative sign. The lower index values indicate a higher quality. On the other hand “brightness” and “softness”, two other significant coefficients, exhibit positive signs, contrary to expectations.

The most obvious conclusion from the price determinant regression is the overriding influence of “city”. As straw has rather high transportation costs and supply often differs between these rather distant sites (distance Delhi-Patna 1029 km, Patna-Kolkata 614 km), the studied markets are fairly isolated from each other. Therefore, it might be reasonable to analyse the three markets separately. However, a greater number of samples per site would be required to enable separate statistical

analyses. On the other hand, because of their apparent substitutability, rice and wheat straw markets in Patna might be analysed together.

The time variables appear to be significant only in the case of rice straw. There is some indication of a cyclical seasonality and a year effect. On the other hand, in wheat, despite the considerable price increases in Delhi in 2009, no year effect can be determined by the regression as prices in Patna decreased. Prices in Kolkata did not vary that much. However, as the study only covered thirteen months, a year effect cannot be accurately determined. Additional data on supply and demand to augment the analysis of price variation might contribute explanatory power.

As in the trait regression, “thinness of the whole straw” appears to have a strong effect on rice straw prices. This indicates a varietal preference which should be further explored.

Conclusions

The study has provided valuable new insights into qualities, perceptions and valuations of wheat and rice straw in urban fodder markets. It has been shown that traders mainly perceive straw quality by post-harvest characteristics. According to the analysis performed so far, these do not seem to have close links to the nutritional quality determined by laboratory methods. The nutritional values found were roughly in line with expectations for wheat but lower than expected for rice. The study showed that the selected markets differed so strongly in their price dynamics that they cannot easily be analysed together. The differences between markets and over time overshadowed variation which could be explained by quality.

5. Overall conclusions and policy implications

The PRA results show that Agro-climatic Zones I and II are fodder deficit and mostly depend on fodder surplus regions (Zones IIIa and IIIb) for their fodder supply. To promote fodder production and marketing, improved fodder storage facilities are needed on-farm as well as along major market routes in the different regions, so that farmers can store fodder to ensure its availability throughout the year. Due to lack of adequate storage facilities and space, producers are forced to dispose of the fodder rather than store it, and therefore they face fodder shortages later in the year and miss opportunities to sell their fodder when prices are higher. Institutional support in the form of credit and creation of fodder banks in different fodder surplus producing as well as deficit areas for maintaining buffer stock is essential. Most fodder markets do not have a dedicated location, operating along the roadsides and having no legal credentials. This becomes a source of exploitation of people in this business. It is envisaged that establishing dedicated and legal market places would facilitate fodder trade significantly and also check corrupt practices and exploitation of poor producers and traders. Fodder is a bulky item, which makes its trading cumbersome and handling difficult. Some traders use compressing machines to make fodder blocks. It is important to develop cost-effective and efficient fodder compressing technology to ease handling and transportation as well as reducing costs. Quality control of manufactured compound feed and concentrates is also essential.

The field survey results show that State Government intervention in fodder production and marketing is non-existent in Bihar, other than when the government arranges for dry fodder and provides transportation support during floods. Fodder production and marketing are not mentioned in the government's agricultural plan, '*Road Map for Agriculture and Allied Sectors'* by the Government of Bihar, nor does fodder production and marketing feature in dairy development programmes. Few, if any, regulatory mechanisms exist for fodder production and marketing in Bihar.

In the post-Green Revolution period, there has been a substantial increase in dry fodder production due to the adoption of the paddy-wheat cropping system, the main source of dry fodder. An increasing pace of crop diversification to meet increasing demand, towards medicinal and aromatic plants and horticultural crops, together with the use of combine harvesters for paddy and wheat harvesting and threshing are perceived threats to fodder production and availability in Bihar.

Fodder in Bihar is traded over long distances. Intra-state trade takes place between surplus and deficit zones, which are often far apart. Inter-state trade takes place in the form of export to Jharkhand in the north, West Bengal, especially Kolkata, in the south and import from Uttar Pradesh into some parts of northwest Bihar. Because of bulkiness, transportation is inefficient and costly. The survey results show that on average transport cost alone accounts for 36% of the final price, with other marketing costs accounting for another 32%. Therefore, technological and financial interventions to ease transportation and reduce transport cost will be beneficial for fodder producers, traders and consumers. Prototypes of small-scale manual and mechanical balers or pressing equipment are available on the world market including in India. These may require local adaptation and dissemination which can be easily done by the public sector research institutions in partnership with fodder traders and producers.

Fodder producers usually feed animals chopped or unchopped straw depending on local practice as well as availability of labour. However, retail fodder traders usually need to chop straw before selling, especially to urban/peri-urban livestock producers because buyers want ease of transportation and less space for storage. Utilization of chopped straw is also more efficient than unchopped straw. Simple, good-quality choppers are rarely found in local markets, but prototypes may be available elsewhere. Therefore, adaptation and dissemination of small-scale manual or mechanical choppers also offer an opportunity for improving feed marketing and its better utilization.

However, even small choppers may be unsuitable for many small-scale fodder producers and fodder traders as they may not be able to use them to their full capacity. Larger traders may be able to own and use them to capacity on their own. One solution may be promoting fodder processing services: the equipment could be individually owned and custom-hired for a fee to others to make full use of the capacity. In the case of farmer groups or cooperatives, the ownership could be held by the group or the cooperative and its use shared for a fee by members. Financial institutions–banks and NGOs—could facilitate acquisition and efficient use of these types of equipment by offering subsidized credit to individuals and groups. The financial institutions could develop a simple business plan showing cost and income flows, rates of return and payback periods so that the credit is granted on a sound financial basis that is easily understandable by the equipment owner.

Prices of dry fodder could also be included in market information systems, being broadcast by radio and TV like other agricultural commodities; newspapers can also publish the prices of dry and green fodder targeting the large number of people involved in fodder production and marketing. Institutional credit could be made available to fodder traders so that they may also conduct business like any other enterprise related to the agricultural sector in the state. Research and extension programmes should be initiated for fodder production. Training of farmers can be organized for fodder production, processing, storage and marketing to prevent spoilage and to make better and judicious use of available feed and fodder being produced in Bihar.

The nutritional quality survey results provide valuable new insights into issues related to fodder attributes, perceptions of these attributes and valuations of wheat and rice straw in urban fodder markets. It has been shown that traders mainly perceive straw quality by post-harvest characteristics. According to the analysis performed so far, these do not seem to have close links to the nutritional quality as determined by laboratory methods. The nutritional values found were roughly in line with expectations for wheat but lower than expected for rice. The study showed that the studied markets differed so strongly in their price dynamics that they cannot easily be analysed together. The differences between markets and over time overshadowed variation which could be explained by quality.

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